DOCUMENT RESUME

ED 200 287 JC 810 209

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TITLE Mathematics in an Individualized Self-Paced Format.
PUB DATE Oct 80
NOTE 21p.; Paper presented at the Annual Convention of the American Mathematical Association of Two Year Colleges (Washington, DC, October 1980).

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Academic Achievement; Attendance Records; *College Mathematics; Community Colleges; Comparative Analysis; Cost Effectiveness; Grading; *Individualized Instruction; *Learning Laboratories; Learning Modules; Lecture Method; *Mathematics Instruction; Peer Teaching; Staff Utilization; Two Year Colleges
IDENTIFIERS *Pima Community College AZ

ABSTRACT

The Math Center described in this report operates at Pima Community College to provide individualized, self-paced instruction as an alternative to lecture courses. The report first describes the Center's staff organization and then examines seven courses offered through the Center on remedial, vocational, and transfer levels. Each of these courses is made-up of three one-credit modules. Policies are then outlined for course registration and scheduling, grading, and student monitoring via attendance records. Discussions follow of: the Center's open-entry policy, which is facilitated by the absence of late registration fees; the options available to students who do not complete work by the end of the semester; and the reasons students have for choosing individualized instruction over the lecture method, or vice versa. A comparison of student success rates in the individualized and lecture instructional modes precedes an examination of special problems centering around the selection, training, and scheduling of student peer instructors. After costs per student credit hour incurred at the Center are compared with costs incurred in traditional lecture settings, the evolution of the Center is traced from its inception in 1974. Forms and cost effectiveness data for the program are appended. (JP)

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MATHEMATICS IN AN INDIVIDUALIZED SELF-PACED FORMAT

by

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Tucson, Arizona
October, 1980

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MATHEMATICS IN AN INDIVIDUALIZED SELF-PACED FORMAT

by

Myrna L. Mitchell

Pima Community College is a multicampus, multicultural community college of about 22,000 students in Tucson, Arizona. About 5,500 of these students attend the Downtown Campus for at least one of their classes. The individualized, self-paced mathematics instruction as an alternative to the lecture-exam classes is unique to the Downtown Campus.

The Math Center is one part of an Alternative Learning Center, consisting of three areas: reading, writing and math. It provides a relaxed atmosphere for study and allows flexible scheduling of a student's required class attendance. Remedial and regular college-level studies are done side by side with no distinction in the treatment of the students, thus removing the stigma of remediation. Tutorial assistance for students of lecture classes and test-proctoring services for classroom instructors are incorporated into the same program as a means of providing instructional support with very little additional staff or facilities needed.

Staff Organization

One math faculty member is assigned to the ALC for the coordination of the program as that person's full instructional load. Responsibilities include hiring, scheduling, training and supervising staff; establishing policies, procedures and record-keeping systems; supervising record maintenance; developing

curriculum; preparing study, evaluative, supplementary and audio-visual materials; assigning special assistance to students as needed; and final grade determination.

The Math Specialists are bachelor-degree level personnel who serve as master tutors or instructional assistants. One specialist is on duty during every instructional hour. He (or she) serves as the immediate supervisor for the peer tutors, does a considerable amount of one-to-one tutoring or small group work, assists in student evaluation, and identifies and assists students who have special learning problems.

One person is a clerical assistant. The assistant has responsibility for recording grades, verifying student registration, maintaining tutor work-time records, maintaining supplies, contacting absentees, tutoring students as time allows and, in general, assisting the instructor.

Peer tutors are responsible for the majority of the personal contact with students. They answer students' questions and explain mathematical concepts and operations, distribute study materials and evaluative items, and assist with clerical tasks including the scoring of quizzes. Presently we have 12 tutors, each work 12-15 hours per week at minimum wage.

Students are an important part of our program -- without them there would be no program or staff! Our facility is basically a room of about 800 sq. ft., part of which is the office area. There is a small testing room which will seat about 7 students and a small office for the instructor. We limit scheduled students to 25 at any given time which allows

for a very few "drop-in" students also. In general, the student to staff ratio is about 5:1, though naturally that fluctuates some with student or tutor absenteeism as well as the proximity of tests in the lecture classes.

Course Offerings

Seven courses are offered in this format. The introductory math, or arithmetic, and beginning algebra are what is often considered as remedial or developmental, and that is where we get nearly half of our student registration. Two technical math courses, including arithmetic, geometry, algebra and numerical trig, are offered to meet the math requirements for the student in a technical/vocational program such as air conditioning or sheet metal. Intermediate algebra, college algebra and trigonemetry are university transferable.

Each course, originally a 3-credit course, is modularized into 1-credit segments called Modules A, B and C, in order to allow for student pacing. Some students complete one credit or less in a semester, others as many as six credits.

We have an agreement with the University of Arizona, just a mile from our campus, to accept the individual credits of college algebra. Thus a student taking the first credit or the first two credits can transfer that and take the remaining credits at the university to complete the course. The intermediate algebra course is organized differently at the two schools and the trig courses differ in the number of credits, so they do not transfer credit-wise.

Registration and Scheduling

A student registers for individualized study through the regular registration procedures with each module being listed as a separate class. Most register initially for all three modules of a course unless they are aware of a learning problem or time constraints. After the first experience, the student is better able to select the appropriate load. Withdrawal from or addition of modules may be done at almost any time during a semester.

The student is urged to visit the Math Center as soon as possible after registration to schedule study hours. Scheduling records are handled by computer and the student receives his choice of hours on a first-come, first-served basis.

All students are shown a brief slide-cassette orientation program on the first visit so that the staff will not have to answer the very same questions for 500 people. The operation of individualized study is explained, pictures of some of the staff are shown, and the student is informed of his responsibilities and what he may expect from the staff.

Grading

Mastery learning is the goal, but we settle for a 70% level and allow retakes to raise a grade at any level. The unit quizzes, which are all open book, are considered to be learning tools and repetition of the quizzing experience is encouraged. Module tests may also be repeated, but with grade discounting.

The student's grade for a module is determined from the quizzes and tests with the quiz average being one-fourth of the grade, the test score the other three-fourths. Grades are

determined on this scale:

90-100	A
80- 89	B
70- 79	C
0- 69	NC

Pima's philosophy is that "NC" is a non-punitive grade and it is not calculated into a student's grade point average. However, it is not counted as a successful grade. Since VA requires repayment of benefits in some cases, it may be punitive.

A separate grade is given for each module. If a student completes all three modules of a course in one semester, the three module scores will be averaged -- if it is to the student's advantage. Also, the student may attempt to raise his overall grade by taking a comprehensive final exam on all three modules. Then the lowest score of the final and the three modules would be dropped for the grade determination. These options for raising a grade are open only to students completing all three credits of a course in one semester.

Attendance

Each student uses an attendance card which is kept in the Math Center. (See appendix A) The 5x8" card identifies, with a color-coded label the courses and modules the student is studying. It provides a chart of attendance showing actual times studied, a record of which evaluative items have been attempted and which passed, a record of instructor conference dates and space for brief notes to the student. Students are not penalized gradewise for non-attendance, but they are expected to make up absences by attending extra instructional

hours. Each student's tests and quizzes are kept in a folder, labeled with the same color as the card's label, and each course has a record sheet specifically prepared for grade computation, for that course. The record sheet is glued in the student's folder. (For a sample record sheet, see Appendix B).

When a student misses a full week we attempt to make a personal contact by phone. If that is not successful, we send a postcard. It was hoped that these contacts had an effect on our average number of visits per week, but the increase in visits do not correlate very well with enrollment increases, nor was there any significant difference in the number of visits when the contacts began. However, we do know of many students who returned after a long absence because of the personal contact, so we feel them worthwhile in spite of the lack of supporting statistics. (See Appendix C for sample postcards.)

Program Fluidity

One advantage of the program is its fluidity. Self-paced, individualized study lends itself to an "open entry" policy. A student may register and begin study or add another module to his current registration at almost any time. The college encourages this by not charging late registration or schedule change fees. "Open exit" is only half-reality so far. A student may complete work at any time during the semester. His records are then transferred to the "completed" file and he does not attend class for the remainder of the semester. Many students who complete early, register for another module.

So for those who finish early, open exit is a reality.

There are two options available to a student who does not complete by the end of the semester all modules for which he is registered. The preferred method from the viewpoint of the staff is for the student to withdraw from all modules which he has not completed. He may re-register for them at any time within a year and all completed evaluative items will be transferred to the new files, allowing continuation rather than repetition of his studies. Under some circumstances, withdrawal and re-registration creates a financial hardship for the student, especially now with tuition being charged as well as registration fees. Then, if the student has met attendance requirements and has successfully completed part of the module, a grade of "I" -- Incomplete -- is given. Administratively "I" grades are avoided if possible due to the paper work involved, the funding situation, and the fact that few students receiving "I's" ever finish their studies.

Individualized study is an alternative to the lecture class. Some students discover that they need or prefer the structure of a formal class. The same textbooks are used in both modes of instruction to facilitate transfer of a student between modes. Seldom has a student changed from individualized study to lecture class within a course, partially due to the student's falling behind the class schedule before he realizes he would prefer the individualized study of the same course. Early in the semester the primary reason for such a transfer is for acceleration of their studies. Later, it is due to their falling behind. They

may drop the 3-credit course which they could not finish and salvage one or two credits in individual study.

Enrollment Growth

Individualized study has proven to be popular with our students. Enrollment has risen from 69 students in Spring 1975, before the courses were modularized, to over 500 students, 1213 credits in Spring 1980.

Success rates figured as the ratio of single-credit successes to total credits of registration are just a few percentage points lower than the lecture class success rates for the same courses in spite of self-pacing and the fact that slow learners and problem learners are placed in the program often instead of in a lecture class. Another factor effecting the comparison of classroom versus individualized study success rates is this: when a student drops out of a class and registers in our program, he is removed completely from the lecture class statistics instead of being counted as a withdrawal from the class. Success rates of both modes are slightly less than 50%. However, at least 66% of the students in individualized study have success in at least one module.

The tutorial services are used by lecture class students on a "drop-in" basis. In fact, when the Alternative Learning Center first opened its doors, tutoring was essentially its only function. Credit instruction did not begin until the second semester of operation. Word of our program has spread to the other campuses and some of their students come for assistance or transfer into our courses on the recommendation

of their instructors.

Problems

Unfortunately, there are some problems also.

1) Dependence on student aides as tutors is a big problem. Federal College Work Study guidelines will not authorize college work study aides to work before the first day or after the last day of class. Pima extends that policy to college-funded student aides as well. It is vital to orient the aides to the procedures, policies and materials before the first student attends class. We have finally received approval for two-day workshops the week before classes begin with wages being funded from an "other compensation" category.

2) Another problem is finding students attending our two-year college who are qualified to tutor the highest level of math courses offered at our school. Not all of our tutors must have that level of math background since trig is the highest course offered for credit in the Math Center, but some must since calculus and differential equations students visit for tutorial assistance. Recently we have been allowed to hire some tutors who are not Pima students as "instructional aides." They earn the same minimum wage as the student aides receive but funding is through the regular college payroll. Many of our instructional aides are attending the University of Arizona.

3) Tutor scheduling is one problem which is unlikely to be solved as long as the peer tutors are themselves students. Their classes tend to be at prime class times which is exactly when the Math Center has its peak attendance and needs the

largest number of staff.

4) Tutor training on a regular basis is highly desirable. It has been extremely difficult, and some semesters totally impossible, to find an hour when all of the tutors can meet, due to their own class schedules. Some semesters we have held duplicate sessions in order to have all the tutors attend.

5) Growth has been so rapid that facilities have not kept pace with enrollments. The Math Center has approximately a 25-28 student capacity, an office area, a testing room with seven student stations, and a small office for the instructor which also houses the math typewriter. Two student stations are carrels equipped with audio-visual equipment, one with a Digitor for practice on basic arithmetic facts, and one with a Northstar computer, and CRT. We have some locally-prepared signed number drills to be used on the Northstar and will be preparing other drills in the future. There is still a great need for a workroom to house the typewriter, phone and a computer terminal, and for an 8-10 student classroom for spontaneous small discussions or for mini-lectures on particular topics such as prime factorization and word problems.

Cost Effectiveness

With larger facilities and slightly increased tutoring staff, the student-instructor ratio could be increased, making the program more cost effective. At present our program costs more per student credit hour than the same courses offered in the lecture class. An analysis is given in Appendix D, but a brief explanation is in order.

During the Spring 1980 semester, we did a time usage

study of the staff in the Math Center. It was determined that approximately 20% of staff time was spent on "drop-in" tutorial assistance and counseling, make-up test proctoring for classroom instructors, and providing special services for students with learning problems or other handicaps. These are free services provided through the Math Center, but not in the lecture classes. Hence to make an adequate comparison of costs, Student Credit Hour (S.C.H.) costs, the costs of the individualized study program are identified as the "Apparent Costs"; that cost decreased by 20%, the "Actual Cost."

The cost for classroom staffing of a 3-credit course by regular faculty was determined as one-fifth of the average math faculty salary on our campus. Hence the change from 1979 to 1980, Associate rate did not change.

Appendix E considers the effects on cost of increasing the number of students per hour or the student to staff ratio.

Evolution of PCC Program

The Math Center began in Fall 1974 with one student aide available a few hours each week to tutor students enrolled in math classes. The next two semesters the center offered individual study in six 3-credit courses -- all of the present courses except trigonometry. It was staffed by two part-time faculty, working alternate days, Monday through Thursday, and some student aides as tutors. No evening hours were planned until an evening class was cancelled due to low enrollment, and the class and instructor were transferred to the Math Center.

Whenever classes were cancelled due to low enrollment, the students were encouraged to enroll in the individualized study courses.

No study or evaluative materials were prepared in advance. Some commercially prepared audio-visual materials had been purchased. By the end of the first year only a couple of tests for each 3-credit course had been prepared. Courses had not been modularized into single-credit offerings. If the student failed the test, he failed the course. There were no alternate forms or retake options. There were no unit quizzes.

At this point the full-time instructor was hired. Priority was placed on the preparation of an assignment sheet for each course and then unit quizzes. With six courses and approximately nine units per course, considerable time was involved in the preparation of just one form of each quiz. Gradually the bank of evaluative items has been expanded to four forms of each quiz and test. The assignment sheet has grown into a study guide including much more than just assignments. A file of supplementary exercise materials has been prepared, some models and puzzles have been purchased or constructed, and a few slide-tape shows have been prepared to meet the students' needs.

The instructor soon realized that the "student-paced" study being offered was not student-paced. Grades could be given only on complete 3-credit courses. The instructor felt that a student who worked faithfully the entire semester, yet progressed slowly should not receive a grade of "NC", No Credit. These students were given "I's" and there were many. In succeeding semesters

these students used the Math Center services as heavily as registered students, but were not counted in the basis for staffing or funding. This was the motivation for modularizing all the courses. The number of "I's" given in a semester has been reduced to one-fourth of the previous levels, even with two and three times the number of students.

Conclusion

The individualized study program at Pima has proved to be a viable alternative to the traditional lecture-exam classes. No claims are made of having found a panacea for mathematics instruction. However, this type of program can be as cost effective as the classroom approach and can provide some degree of success to a larger percentage of students.

APPENDIX A

Attendance Card

Address-
Zip-
Phone-
Hours-

This Column Official Use Only

Date Passed

Quiz
1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

Test
I
II
III

Week

1	In	Out	8/27	2	In	Out	9/3	3	In	Out	9/10	4	In	Out	9/17
M				M	Labor Day			M				M			
T				T				T				T			
W				W				W				W			
Th				Th				Th				Th			
F				F				F				F			

5	In	Out	9/24	6	In	Out	10/1	7	In	Out	10/8	8	In	Out	10/15
M				M				M				M			
T				T				T				T			
W				W				W				W			
Th				Th				Th				Th			
F				F				F				F			

Conference Week

Conf: I
II
III

VA BENEFITS? Yes ___ No___

OTHER BENEFITS? Yes ___ No___

If yes, total credits this semester _____

Week

9	In	Out	10/22	10	In	Out	10/29	11	In	Out	11/5	12	In	Out	11/12
M				M				M				M	Vets Day		
T				T				T				T			
W				W				W				W			
Th				Th				Th				Th			
F				F				F				F			

Conference Week

13	In	Out	11/19	14	In	Out	11/26	15	In	Out	12/3	16	In	Out	12/10	17	In	Out	12/17
M								M				M				M			
T								T				T				T			
W								W				W							
Th	Thanksgiving							Th				Th							
F								F				F							

Exam Week

No Testing After Tuesday Dec. 18

Conference Week

APPENDIX B

Sample Record Sheet

Date _____ Receipt checked? _____ Initials

MATH 60 RECORD SHEET

Name _____ Last Pima Math Course taken _____

Student No. _____ Placement Test taken Yes No

Address _____ I am registered for: 60A 60B 60C
zip (circle the correct ones)

Phone _____

Lab hours: _____

Module I Quiz	Date	Score	Retake		Module
1.	_____	_____	_____	Quiz Average_____	60A_____
2.	_____	_____	_____	Test I _____ (Test counts 3 times)	
3.	_____	_____	_____	Mod I Average_____	
Module II					
4.	_____	_____	_____	Quiz Average_____	60B_____
5.	_____	_____	_____	Test II _____	
6.	_____	_____	_____	Mod II Average_____	
Module III					
7.	_____	_____	_____	Quiz Average_____	60C_____
8.	_____	_____	_____	Test III _____	
9.	_____	_____	_____	Mod III Average_____	
10.	_____	_____	_____		

CONFERENCES	I	II	III
Date & Initials:	_____	_____	_____
Progress:	_____	_____	_____
Comments:	_____	_____	_____

APPENDIX C

Postcards

_____
Date

We have missed you in Math ___ class.

There are only ___ weeks left in the semester and you must complete ___ quiz(zes) and ___ test(s) to earn the ___ credits for which you are registered. ___ credit(s) is(are) completed. Please come in soon.

If you feel you cannot do that much, you may still be able to complete part of the credits. Come in and we will help you work out a schedule.

If you have withdrawn from the class, please take a minute to call 884-6548 and leave a message for Myrna Mitchell.

If you do not complete your work and do not withdraw, your grade will be "NC"--no credit. If you are receiving Veterans' Benefits, an "NC" may put you in financial trouble.

Hoping to hear from you.

M. Mitchell

Dear _____:

Our records show that you have scheduled times to attend the Math Learning Center for individual study of Math _____. However, it appears that you are not attending regularly.

Irregular attendance is usually an indication of irregular study habits, which may lead to the non-completion of work at the end of the semester.

If you are receiving veteran's, or other benefits, and you do not pass the courses for which you are registered, you may be required to repay some of your benefits.

How about stopping by to discuss it with us, or call 884-6548 and leave a phone number so we can call you to discuss it.

Date _____ Myrna Mitchell

APPENDIX D

PIMA COMMUNITY COLLEGE

MATH INSTRUCTIONAL COST -- FALL 1979

Classroom:

Average class size (End of late registration) 27 = 81 S.C.H.

Cost by type of staffing:

Associate Faculty	$ 900.00	$11.10/S.C.H.
Regular Faculty	1,620.00	20.00/S.C.H.
Ratio by courses:	2.5 associate: 3 regular	
Weighted average cost	1,227.00	15.20/S.C.H.

Individualized Study:

Registration 1204 S.C.H. Student:Staff Ratio ≈ 5:1

Personnel Costs:

Regular Faculty	5,700	
Associate Faculty	15,000	
Clerical Assistant	2,250	
Peer Tutors (at $2.90/hour*)	9,083	Apparent cost
Total	$32,033	$26.60/S.C.H.

Actual cost of individualized instruction is less due to the services provided:

Non-instructional hours tutoring: $1,020
11 hrs/wek, 2 tutors, $2.90/hr

Tutorial assistance, make-up test proctoring, special services for handicapped students: 20% of staff time

Actual cost adjusted for services:
(32,033 - 1,020) x .80 = 24,810 $20.60/S.C.H.

Comparison of the cost of the two modes:

Classroom	Individualized Study Apparent	Individualized Study Actual
$15.20/S.C.H.	$26.60/S.C.H.	$20.60/S.C.H.

* minimum wage, Fall 1979

PROJECTED INSTRUCTIONAL COSTS - FALL 1980

Classroom:

Average class size 27 = 81 S.C.H.

Cost by type of staffing:

Associate Faculty	$ 900	$11.10/S.C.H.
Regular Faculty	1,818	22.40/S.C.H.

Ratio by courses: 2.5 associate: 3 regular

Weighted average cost	1,318	16.30/S.C.H.

Individualized Study:

Registration 1250 S.C.H. Student : Staff ≈ 5:1

Personnel Costs:

Instructor	(17 weeks)	9,000	
Specialists	(17 weeks)	7,000	
Assistant	(18 weeks)	4,500	
Tutors 12 at 12 hrs/wk $3.10/hour *	(16 weeks)	7,150	
	Total	$27,650	Apparent Cost $22.10/S.C.H.

Adjustment for services:

Tutors (22 hrs/wk)	1,091
Service	20% of staff time

Actual cost:

(27,650 - 1,091) x .80 = $21,247	Actual cost $17.00/S.C.H.

Comparison of the cost of the two modes:

Classroom	Individualized Study Apparent	Actual
$16.30/S.C.H.	$22.10/S.C.H.	$17.00/S.C.H.

* Minimum wage, Fall 1980

APPENDIX E

DECREASING THE COST PER S.C.H.

Facilities in our present Math Center force a limit of 25 students scheduled during any given hour.

There are 49 instructional hours in a week.

Total capacity: 1225 S.C.H., which is exceeded due to early completions, late registrations, and absenteeism.

Costs of such a program could be decreased by:

1. Increasing the number of students per hour, or
2. Increasing the student to staff ratio.

COMPARISON OF APPARENT COST PER S.C.H.

With Student and Staff Size Changes

Students/Hour	Number of Additional Tutors * (49 hours, 16 weeks, $3.10/hr) Resulting Student: Staff Ratio		
	0	2	4
25 Students/Hour	22.10		
1250 Credits	5:1		
35 Students/Hour	15.80	18.60	
1750 Credits	7:1	5:1	
45 Students/Hour	12.30	14.45	16.60
2250 Credits	9:1	6.5:1	5:1

*No consideration was given to staffing which would give a lower student to staff ratio than 5:1.

This analysis could be continued, but it would be hard to maintain that personal, friendly atmosphere if the program gets too large. Besides, it is satisfactory to offer a program which can absorb the costs of many services and still does not cost more than lecture class instruction.

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